

# Neuro-otology Testing

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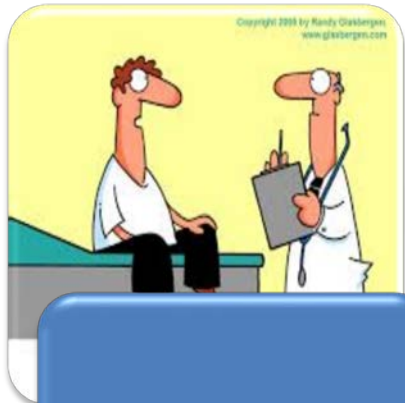
# Neuro-otology testing

- Diagnostic.
  - Assess the function of the inner ear and central signs.
    - Hearing, balance and CN8.
    - Localise.
    - Oculomotor function.
    - Diagnose specific conditions.

# Neuro-otology testing

- Rehabilitation.
  - Confirm/localise a vestibular cause.
  - Measure changes in function over time.

# What do we do?



Detailed History



Neuro-  
otological  
function testing



Particle  
repositioning  
maneuvers  
(as indicated)



Feedback,  
Counseling,  
Report

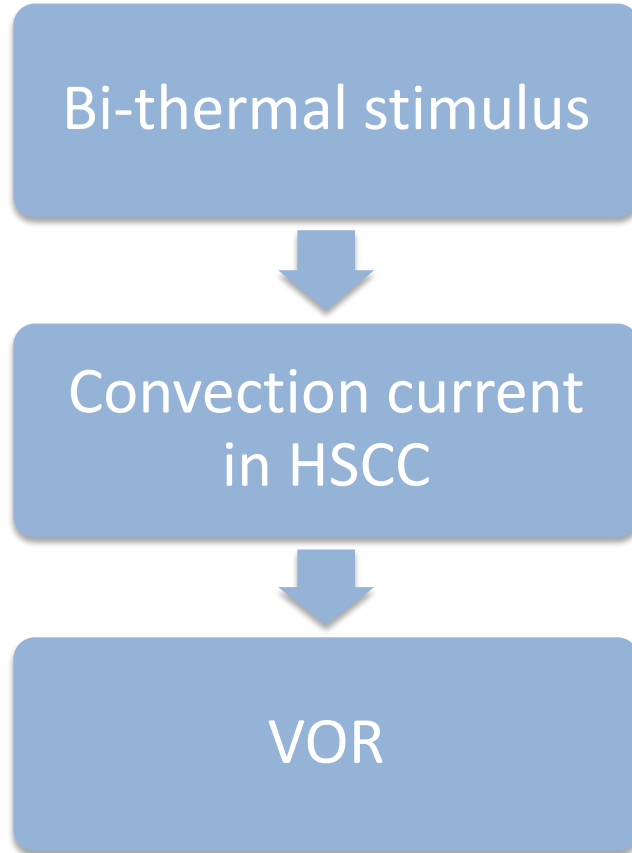
# Balance function test

- Most tests measure the output of the vestibular system
  - VOR & VSR
- Recorded at rest
- Recorded in response to vestibular stimulation.

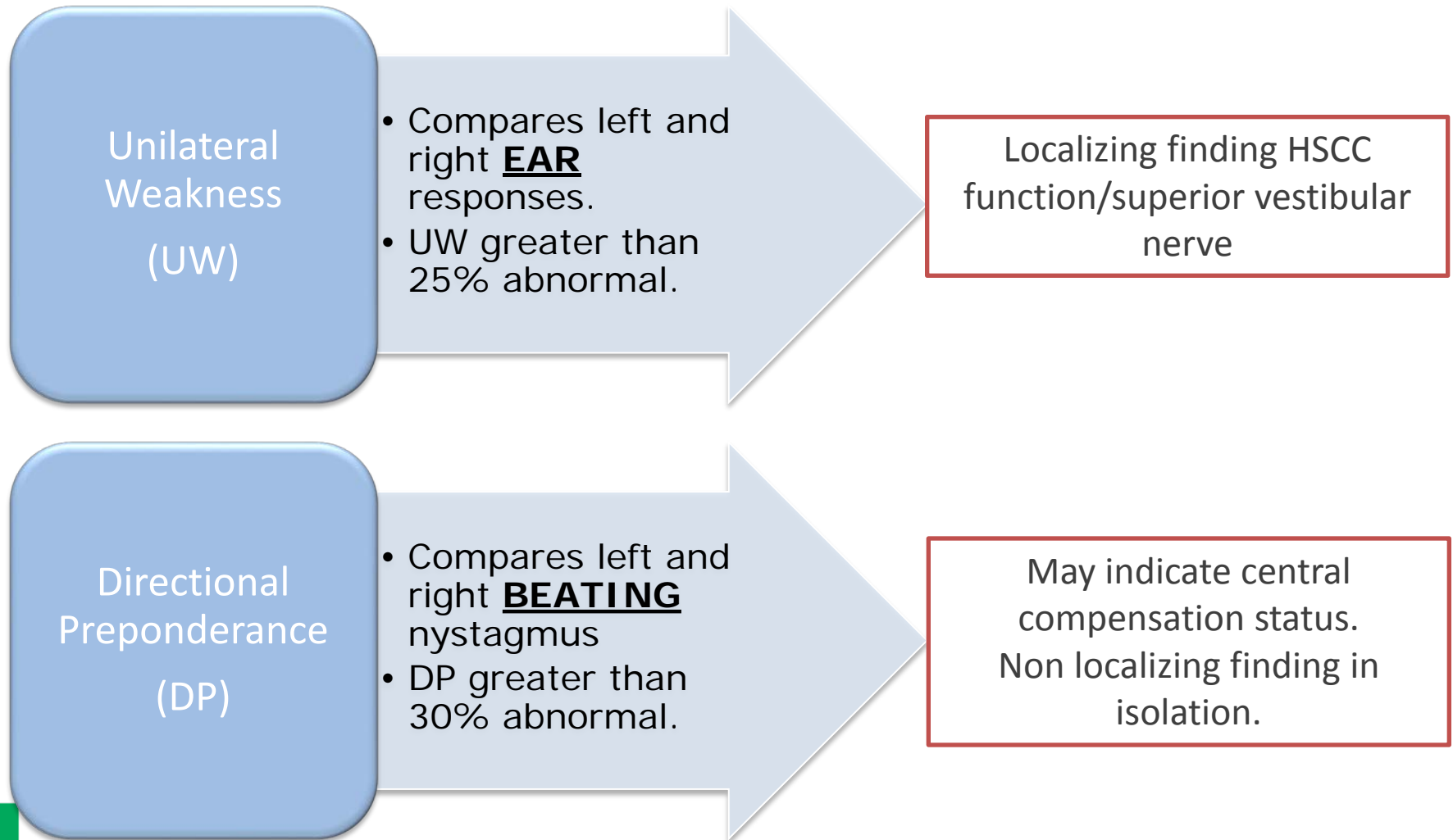
# Semi-circular canal (SCC)

- Horizontal SCC assessed by
  - Caloric
  - vHIT
  - Rotational chair.
- Recording the VOR.
- Anterior and Posterior SCC assessed by
  - vHIT LARPs and RAPLs

# Caloric



# Caloric analysis



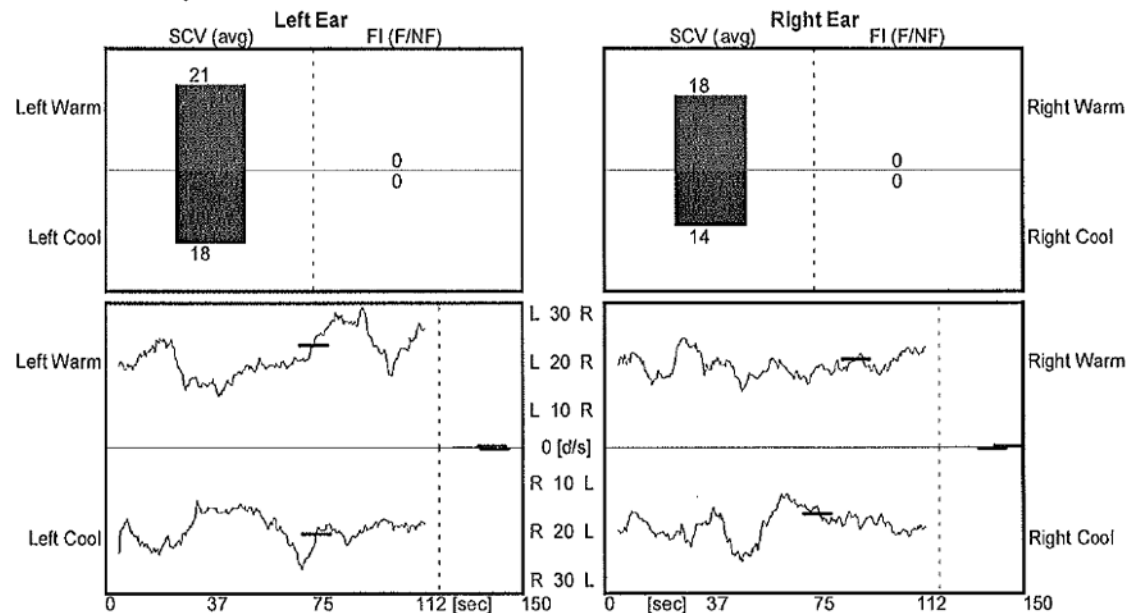


# Normal caloric results

Normal HSCC function bilaterally.

- UW = 10%
- DP = 1%

## Caloric Summary

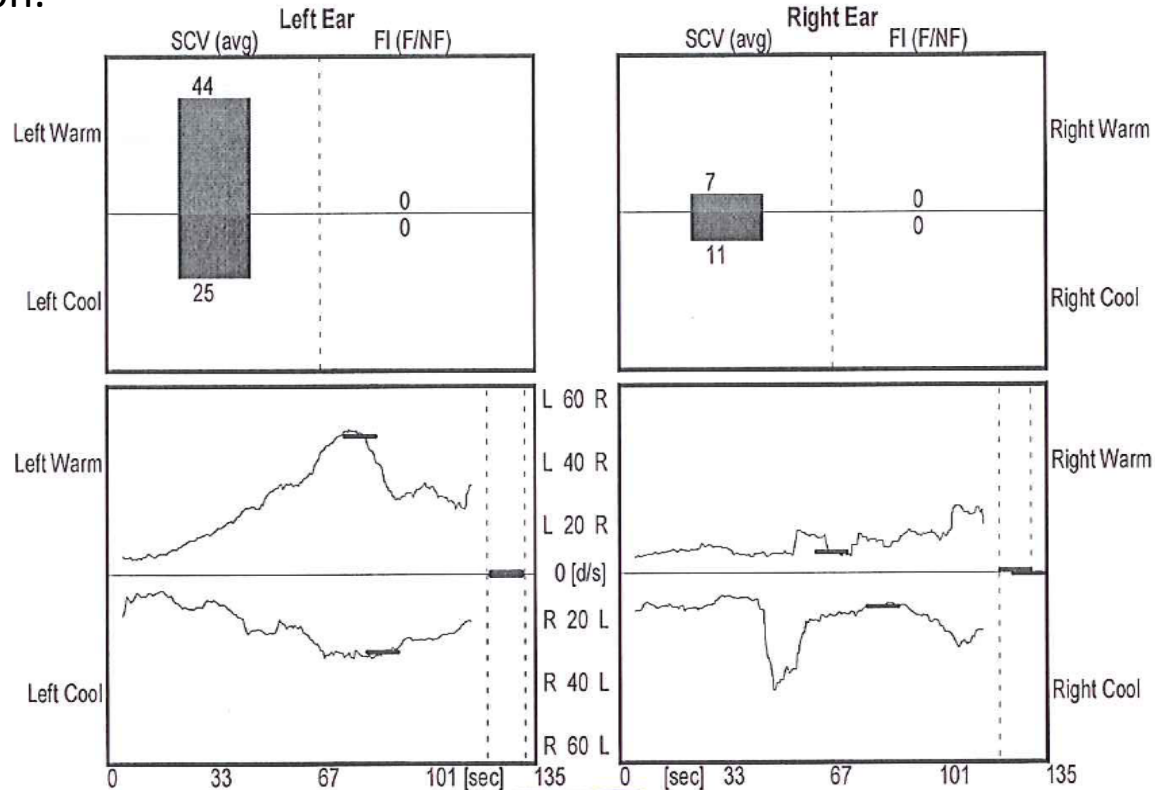


RVR (UW): Right Ear Response 10% weaker  
DP: Right beating response 1% stronger  
Total Eye Speed: 71 [deg/sec]  
Spontaneous Nystagmus: None

# Abnormal caloric results

Unilateral right HSCC dysfunction.

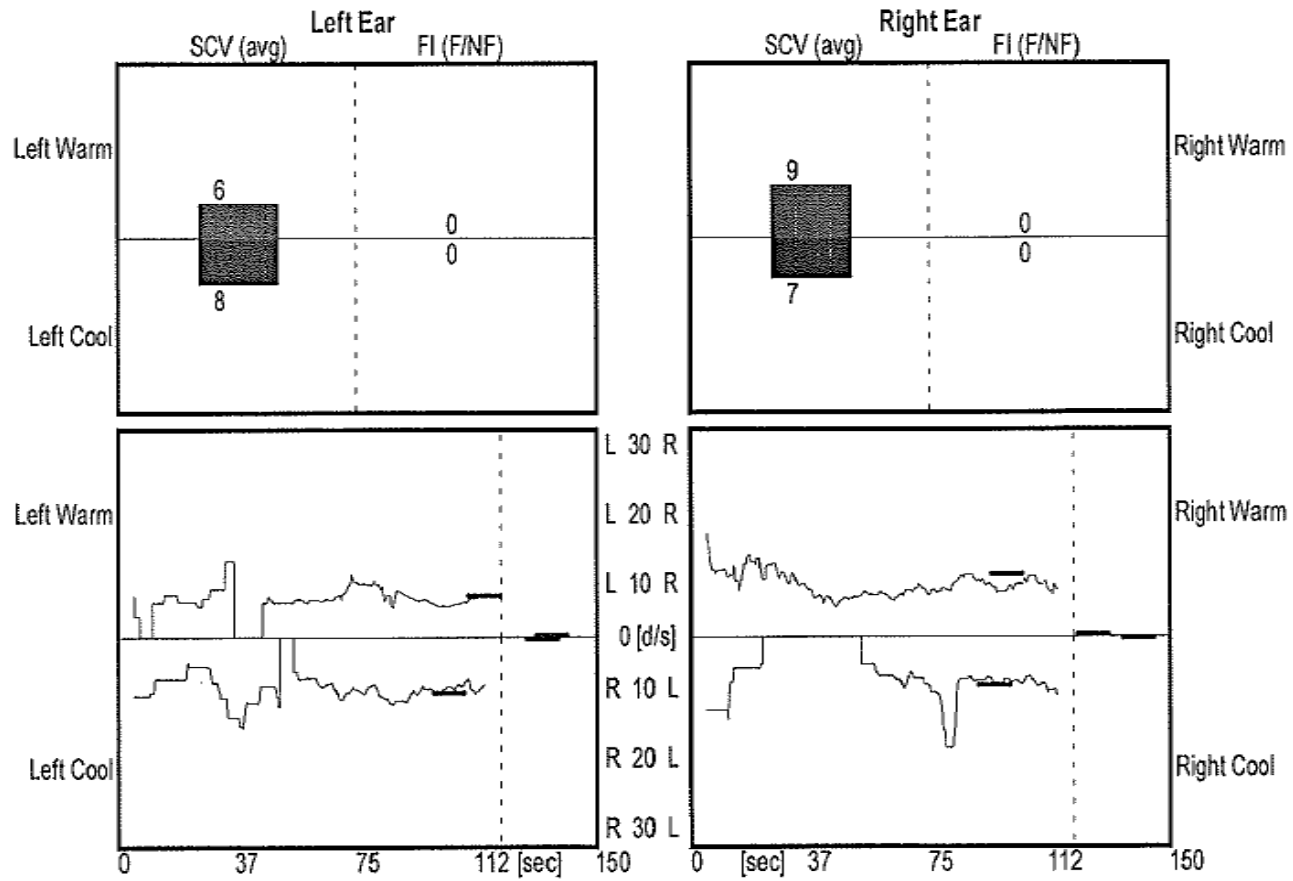
- $UW = 60\%$
- $DP = 28\%$



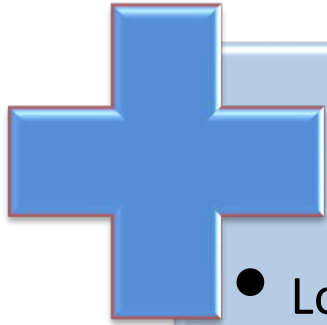
◆ RVR (UW): Right Ear Response 60% weaker  
◆ DP: Left beating response 28% stronger  
Total Eye Speed: 86 [deg/sec]  
Spontaneous Nystagmus: None

# Abnormal caloric results

Bilateral HSCC dysfunction.

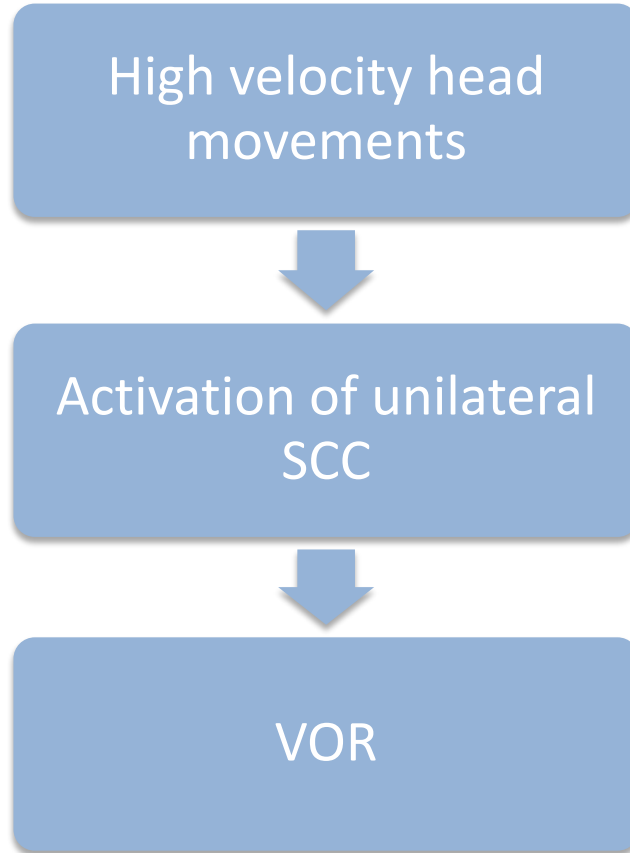


# Advantages & disadvantages of calorics

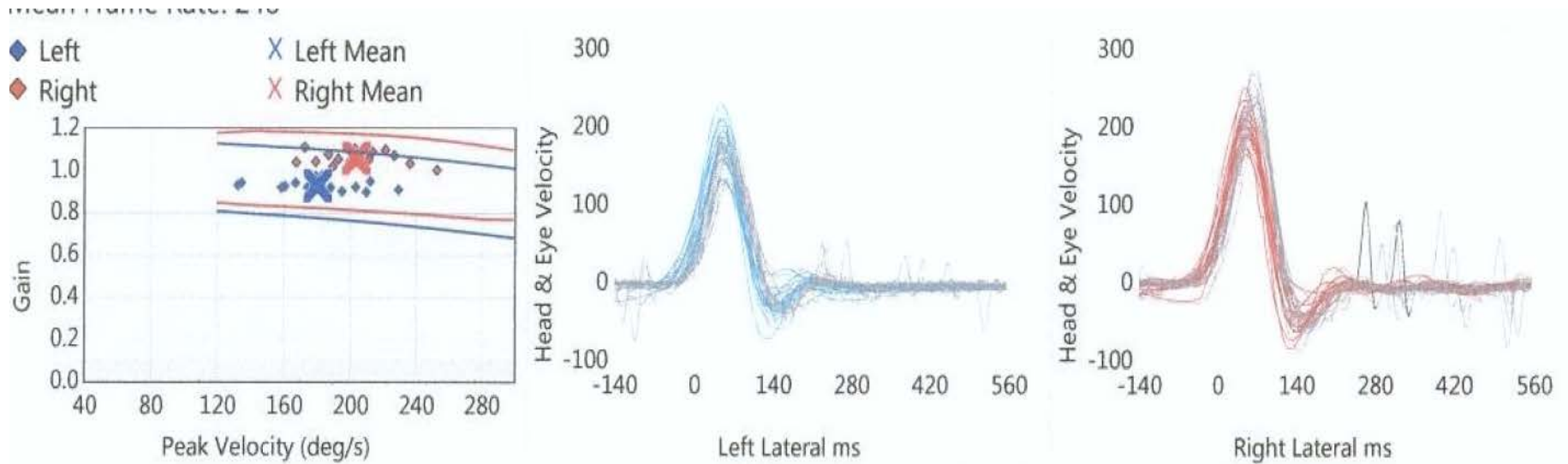


- Localizing information about HSCC function
- Compensation
- Peripheral and central indicators
- Variable results
- Subject to problems with temperature transference (eg: ME pathology) & non-physiologic response
- Impacted by poor response state
- Spontaneous nystagmus
- Impacted by some medications.

# Video head impulse test (vHIT)



# Normal vHIT bilaterally



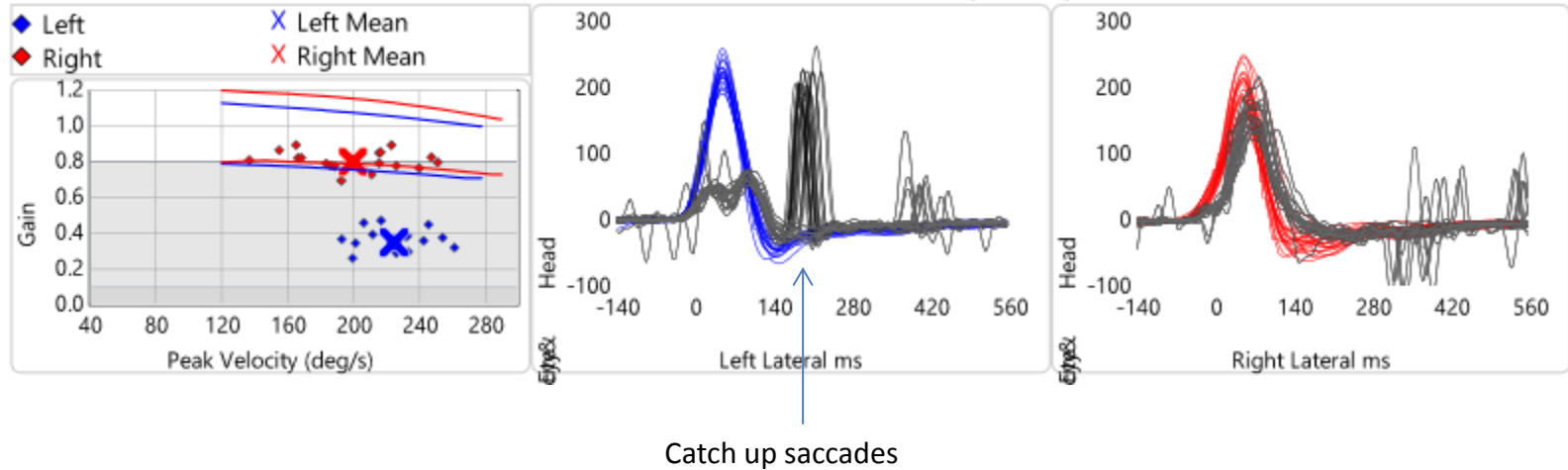
Blue trace = left head movement.

Red trace = red head movement.

Grey traces = eye movements in response to head movement.

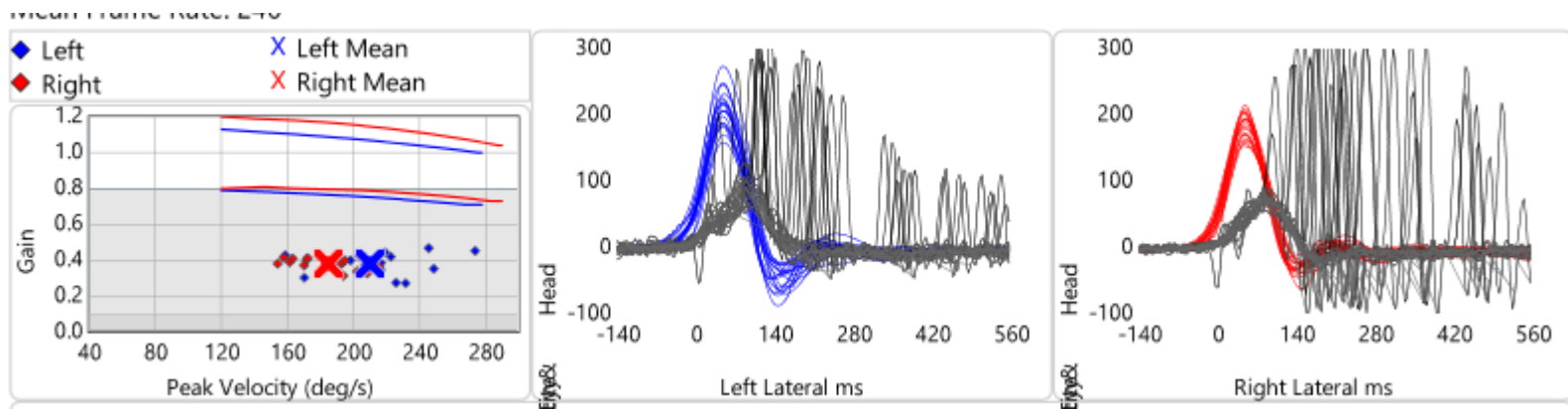
# Abnormal vHIT

Unilateral left HSCC dysfunction.



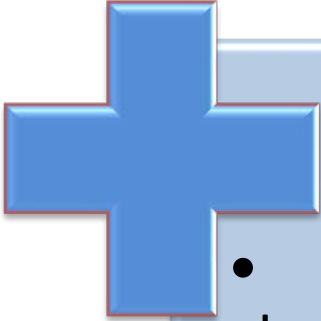
# Bilateral abnormal vHIT

Bilateral HSCC dysfunction.



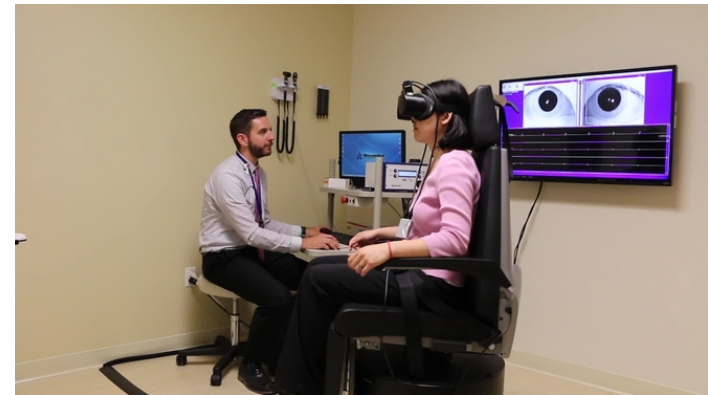
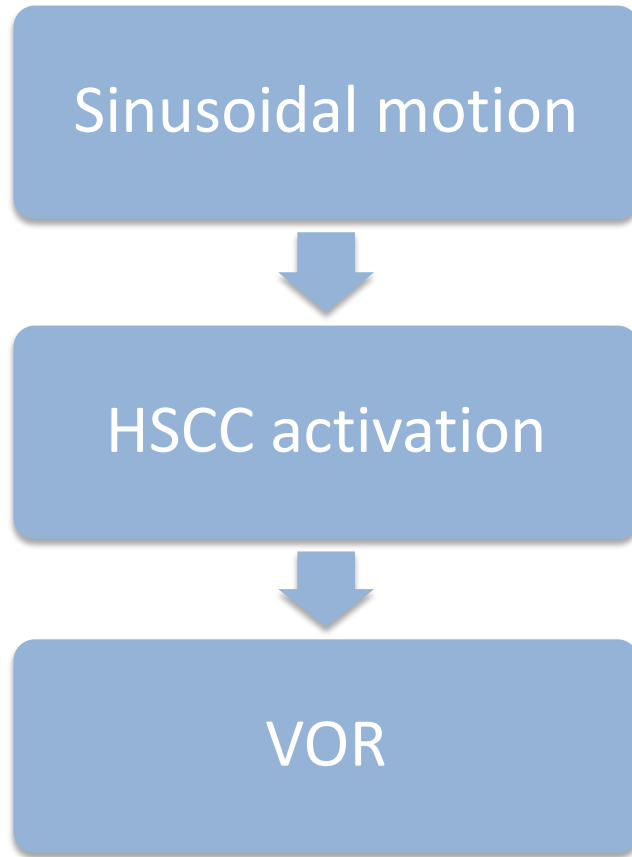


# Advantages & disadvantages of vHIT



- Localising information about SCC function
  - High frequency
  - Able to assess all 6 SCCs.
  - Can assess visual vestibular interaction
  - Monitor a patient's vestibular function over time
  - Not impacted by response state
- No measure of central compensation
  - Unable to performed with cervical restrictions

# Rotational chair - SHA



# Rotational chair -SHA analysis

## Gain

- Ratio of head to eye movement. A peripheral HSCC vestibulopathy causes a reduction in gain.

## Phase

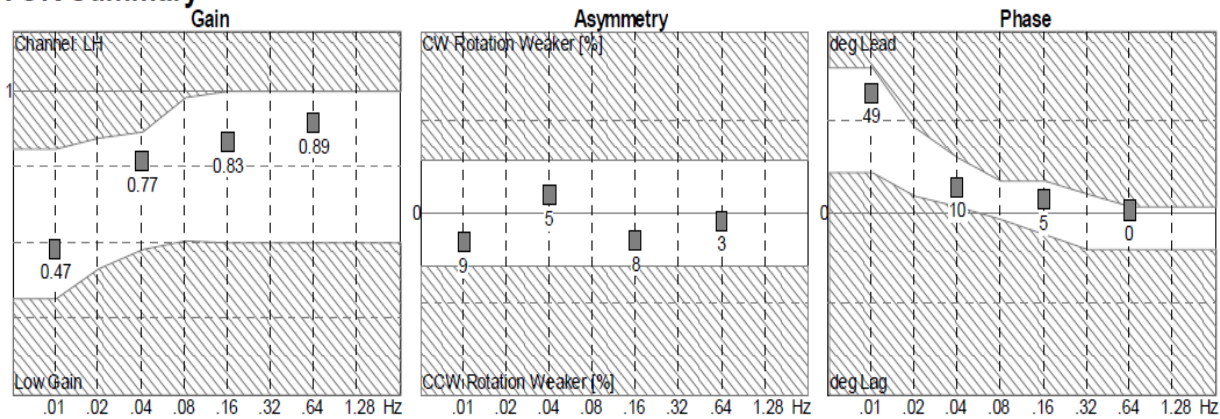
- Timing between head and eye movement.

## Symmetry

- Comparison between the eye velocities with rotation to the right compared to the left. An asymmetry suggests an uncompensated peripheral lesion.

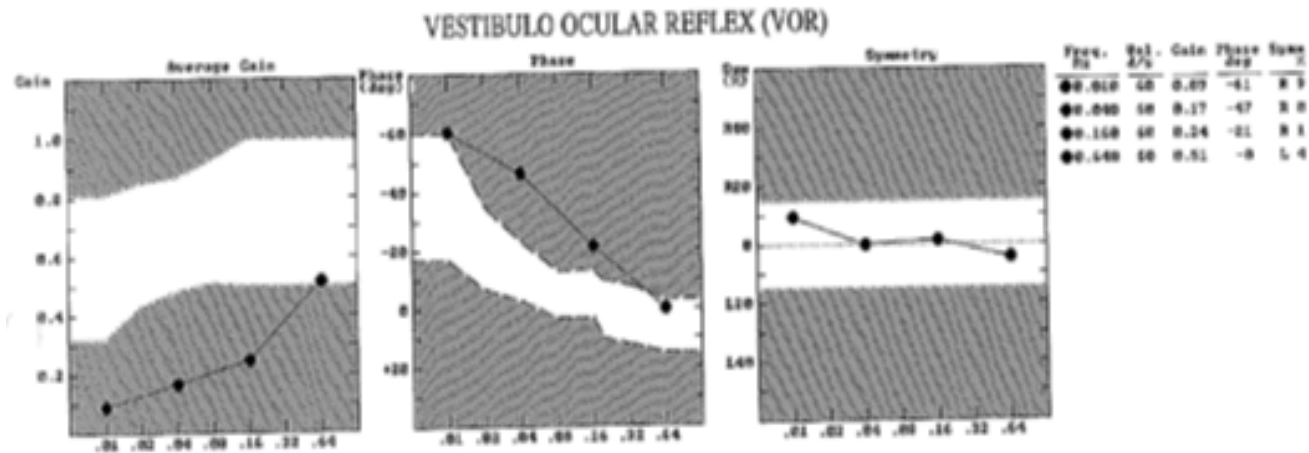
# Normal SHA

## VOR Summary



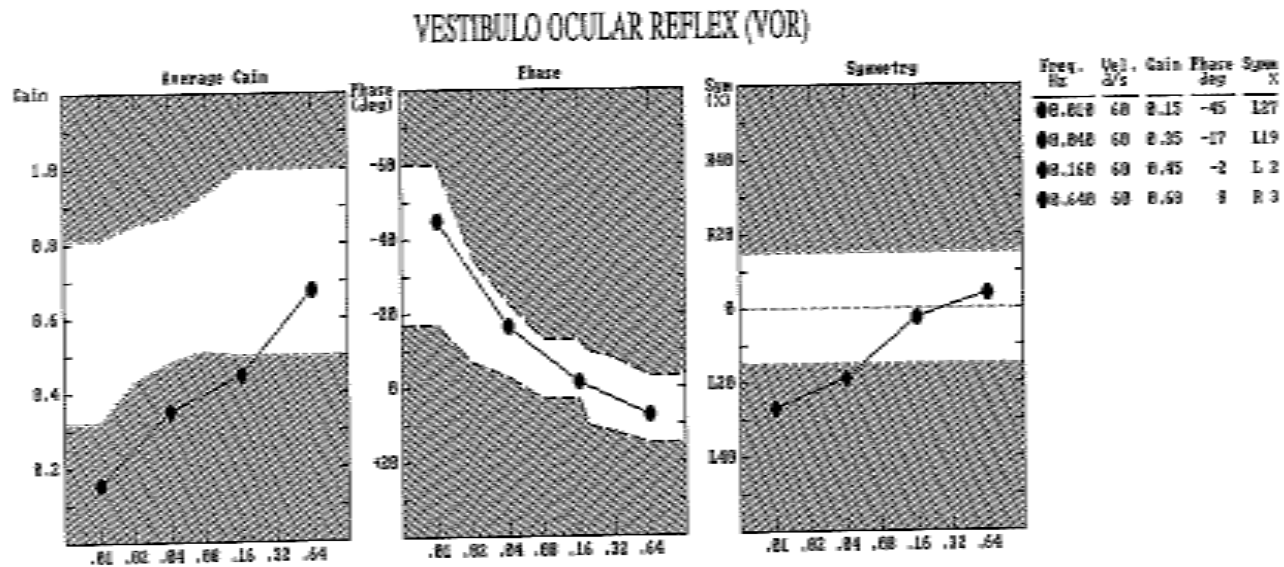
# Abnormal SHA

HSCC hypofunction with evidence of compensation.



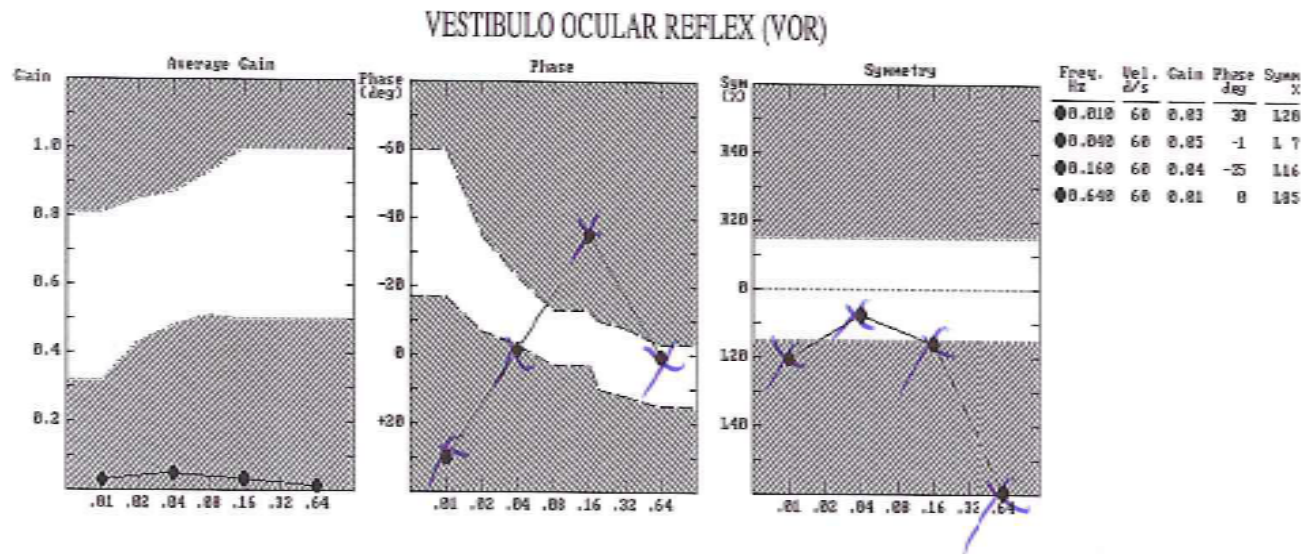
# Abnormal SHA

HSCC hypofunction with the lesion is not fully compensated.

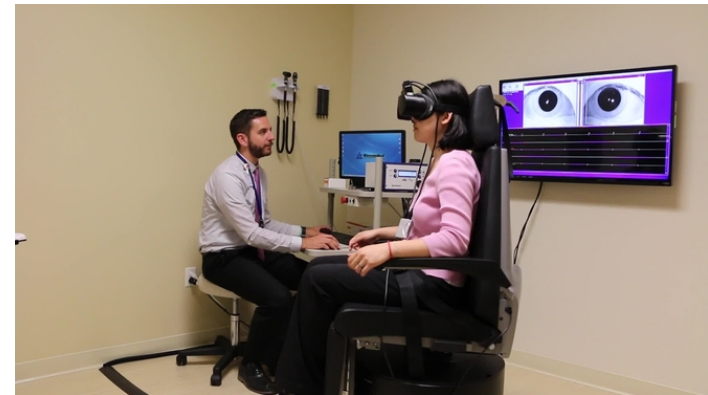
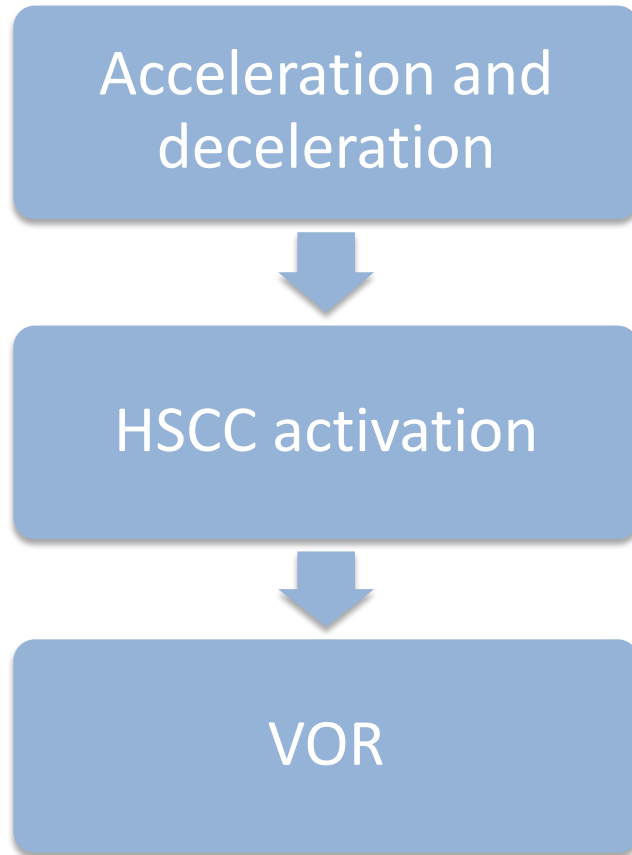


# Abnormal SHA

Consistent with a bilateral vestibulopathy.



# Rotational chair – Step Velocity





# Time constants

- The rotational chair accelerated (100 degrees/second) in a clockwise direction and then the movement stops (decelerates) simulating anticlockwise head movement. This is then reversed with an anticlockwise rotation and deceleration.
- The resultant VOR is measured and provides information about the horizontal semicircular canal function.
- The vestibular-ocular reflex is initiated by the initial acceleration and then decays over time. The amount of decay is measured and called a “time constant.”
  - Time constants less than 10secs consistent with HSCC hypofunction.
  - Time constants greater than 30 secs consistent with a possible central pathology.

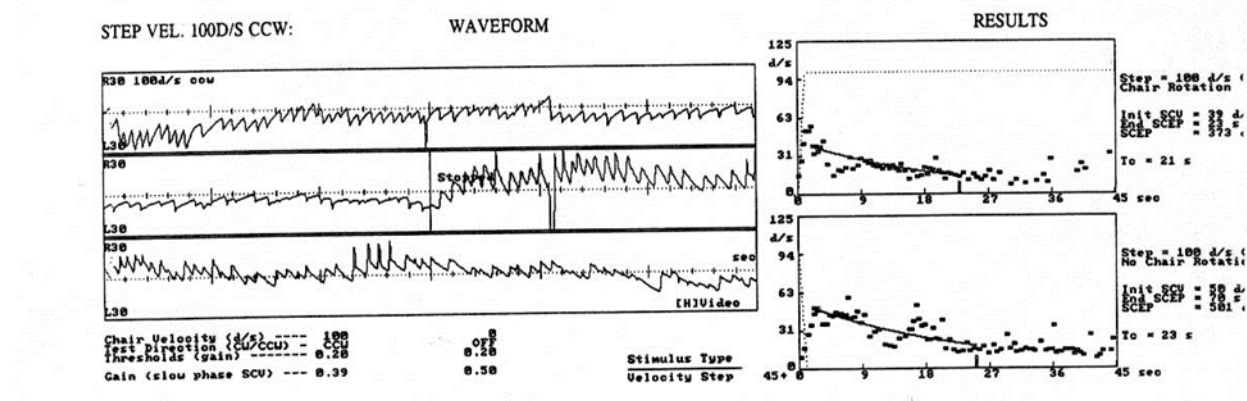
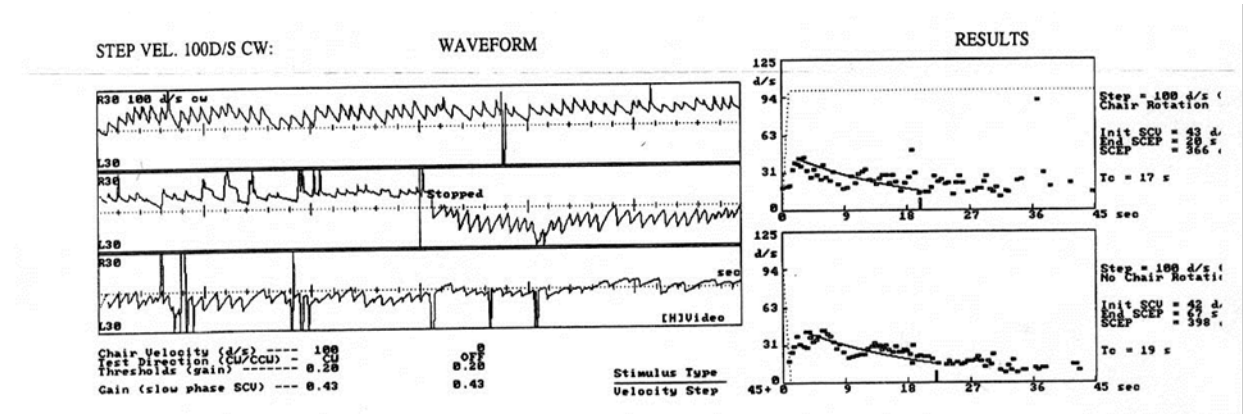
# Normal step velocity

CW 17

CW Step 19

CCW 21

CCW stop 23

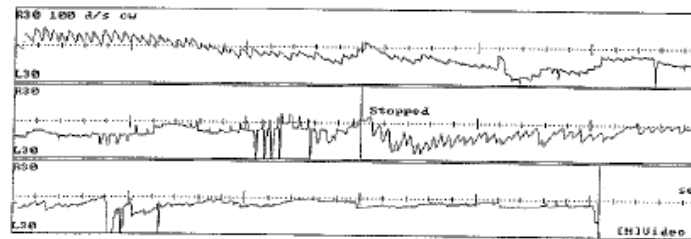


# Abnormal step velocity

CW 11

STEP VEL. 100D/S CW:

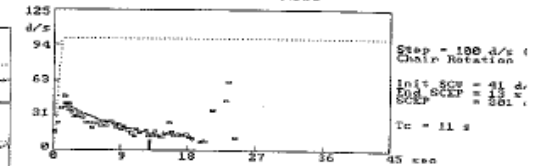
WAVEFORM



Chair Velocity (d/s) --- 100                    100  
Test Direction (CW/CCW) --- CW                OFF  
Thresholds (gain) --- 0.20                    0.20  
Gain (slew phase SCU) --- 0.41                0.27

Stimulus Type  
Velocity Step

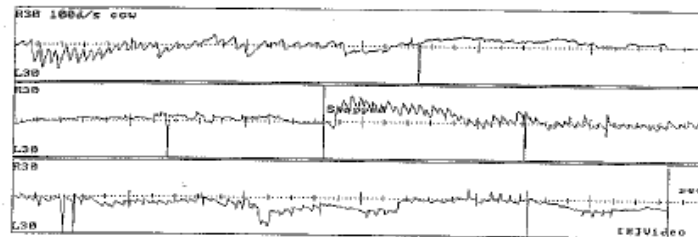
RESULTS



CW Step 5

STEP VEL. 100D/S CCW:

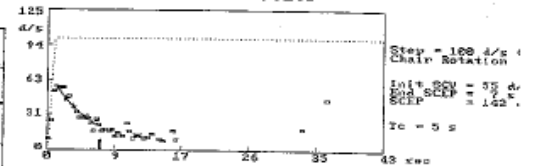
WAVEFORM



Chair Velocity (d/s) --- 100                    0  
Test Direction (CW/CCW) --- CW                OFF  
Thresholds (gain) --- 0.20                    0.20  
Gain (slew phase SCU) --- 0.56                0.46

Stimulus Type  
Velocity Step

RESULTS



CCW stop 13

STEP VEL. 100D/S CCW:

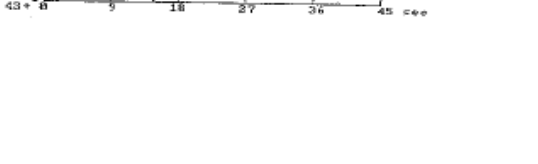
WAVEFORM



Chair Velocity (d/s) --- 100                    0  
Test Direction (CW/CCW) --- CW                OFF  
Thresholds (gain) --- 0.20                    0.20  
Gain (slew phase SCU) --- 0.56                0.46

Stimulus Type  
Velocity Step

RESULTS



# Advantages & disadvantages of rotational chair testing



- Measure of central/peripheral vestibular dys/function
- Mid frequency (0.01 - 0.64Hz) HSCC function
- May provide a measure of central compensation (for UW).
- May confirm bilateral HSCC dysfunction
- Can assess visual vestibular interaction
- Monitor a patient's vestibular function over time
- Does not provide localising (side specific) information
- Small unilateral HSCC dysfunction may not be detected
- Affected by response state and some medications
- Similar results may be seen in central and peripheral pathologies

# Otolith function

- Saccular function/inferior vestibular nerve
  - cVEMPs
- Utricle function/superior vestibular nerve
  - oVEMPs

# cVEMPs

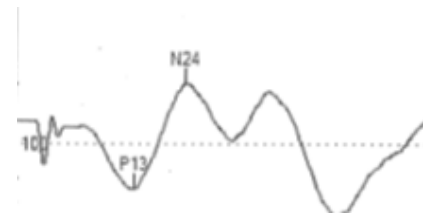
Air conduction stimuli



Vestibulo-cervical reflex



Ipsilateral relaxation of  
SCM



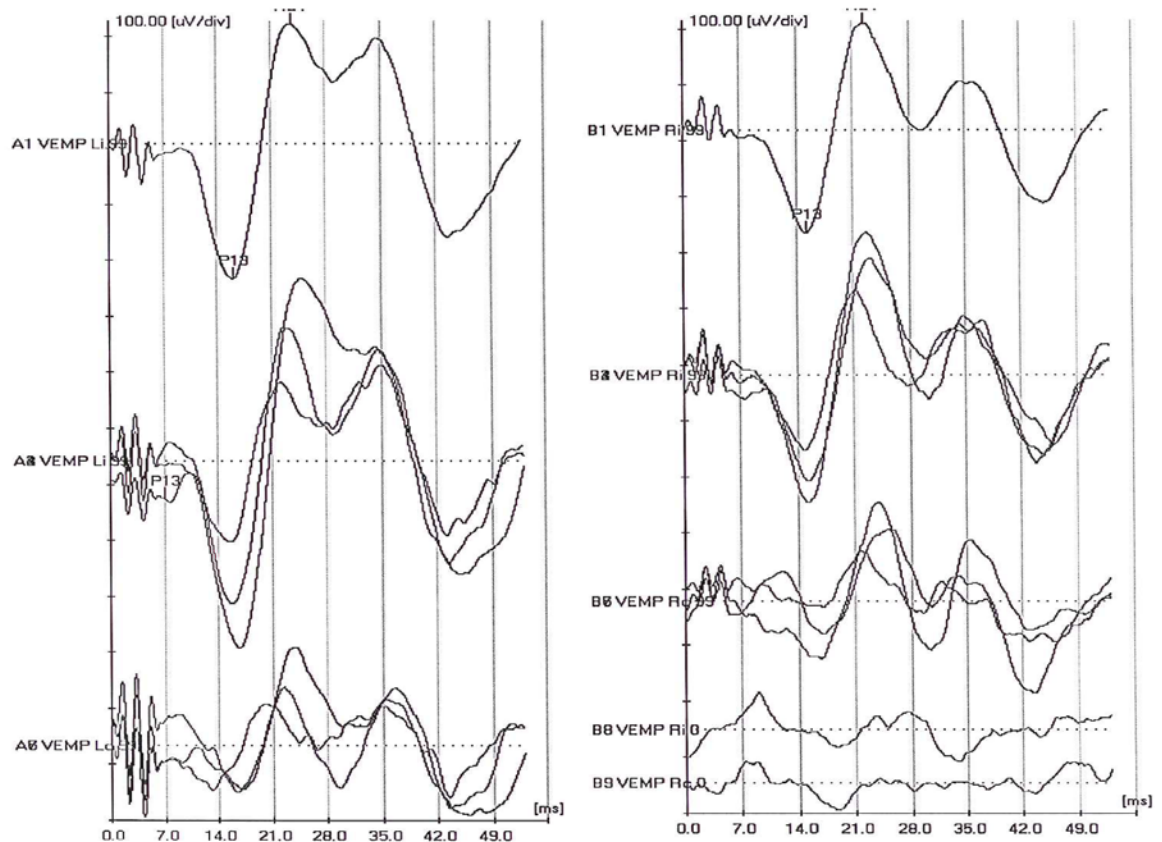
# Normal cVEMP bilaterally

Consistent with normal saccular function bilaterally.

Left  
interamplitude  
Right  
interamplitude

135.22

147.89



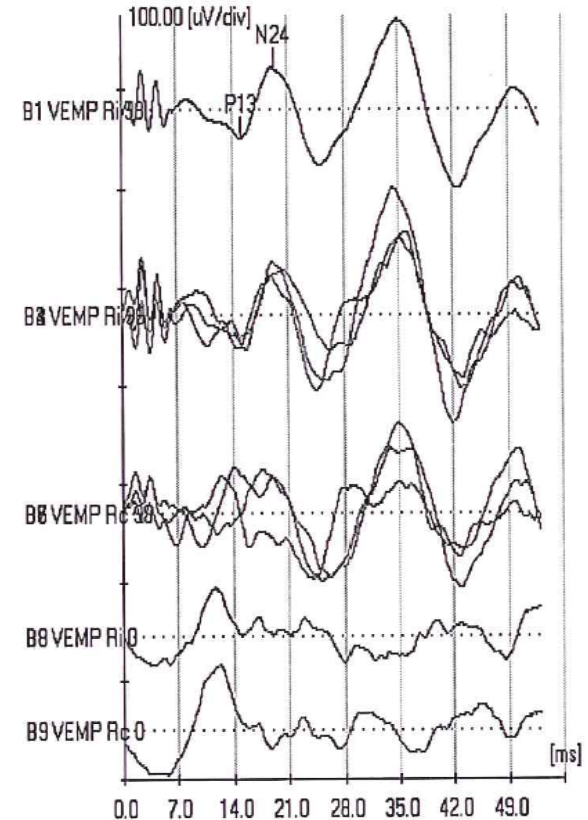
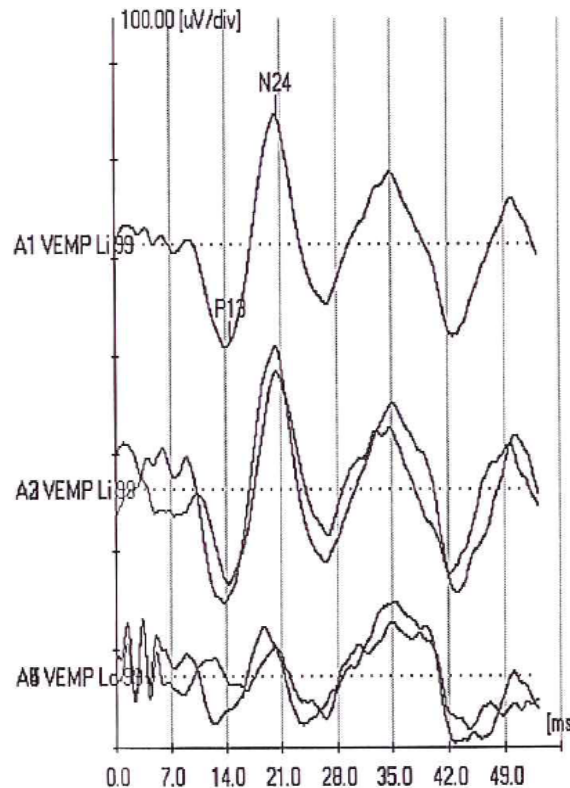
# Abnormal cVEMP

Consistent with a right saccular impairment.

Left  
interamplitude  
Right  
interamplitude

135.22

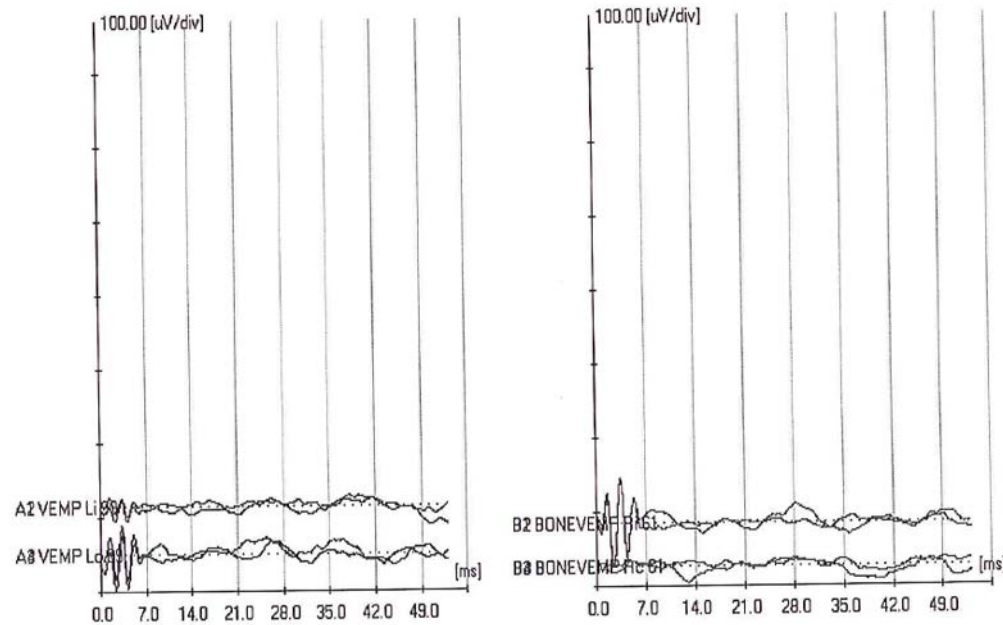
33.43





# Bilateral abnormal cVEMP

Consistent with a bilateral saccular pathology.

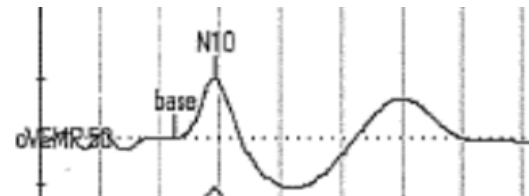
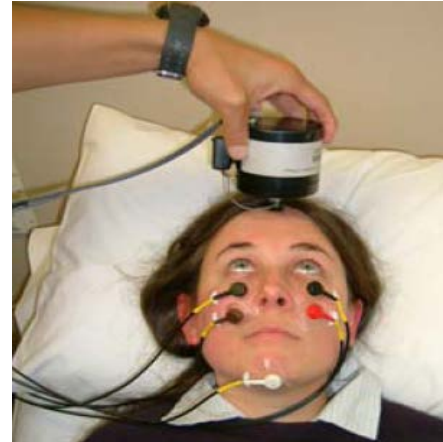
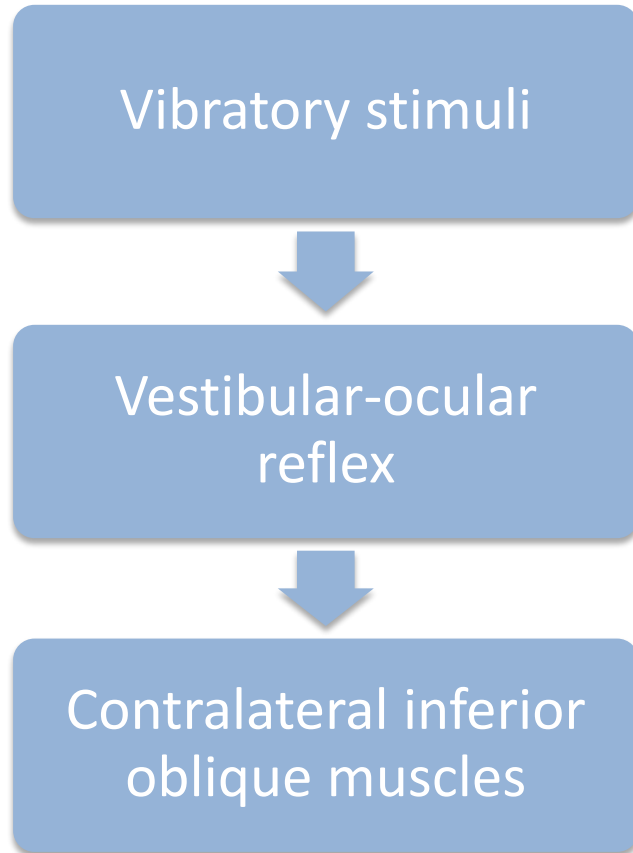


# Advantages & disadvantages of cVEMP



- Information about saccule/inferior vestibular nerve function (localising information)
- Indication of SSCD
- Assist with the diagnosis of vestibular neuronitis.
- Requires adequate SCM contraction (difficult for the elderly and those with neck problems)
- Inconclusive with conductive hearing losses
- Does not provide a measure of central compensation

# oVEMPs



# Bilateral normal oVEMPs

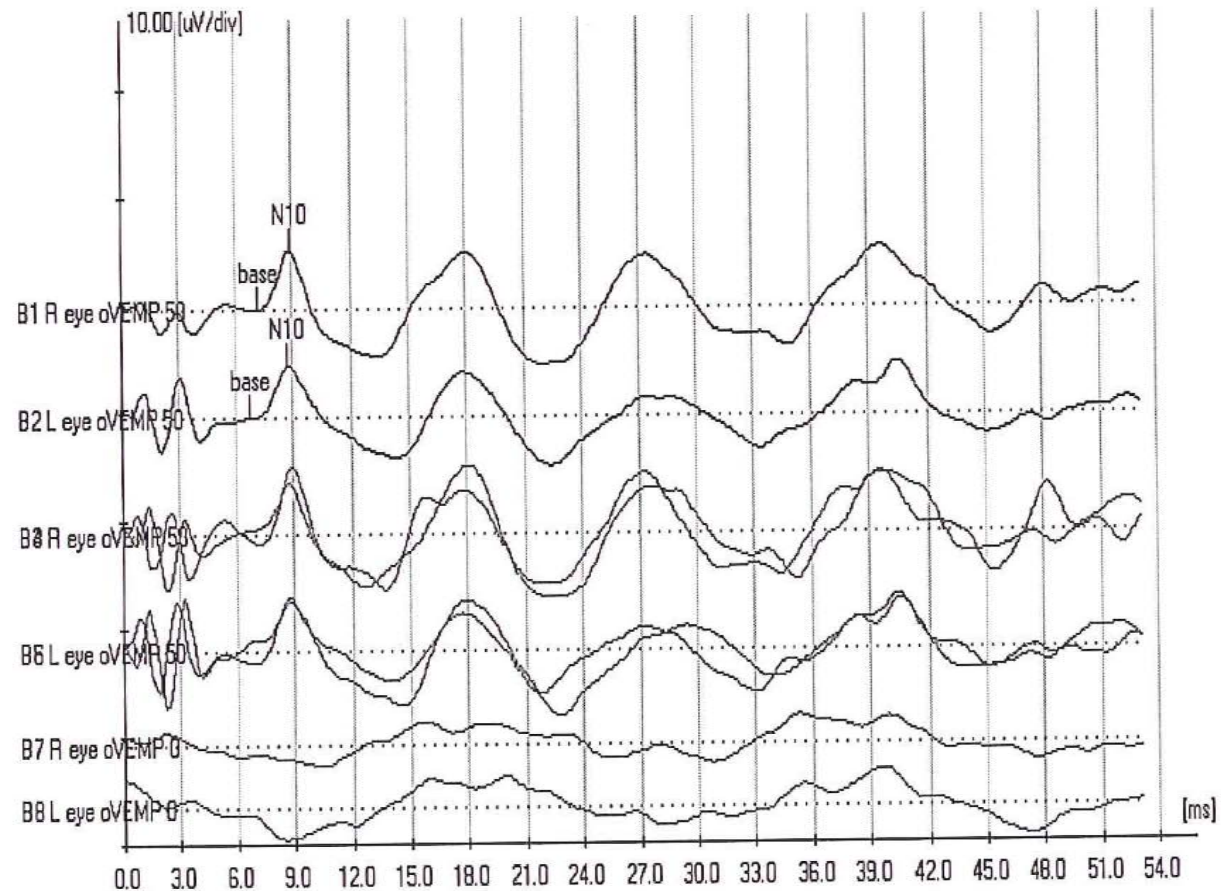
Consistent with normal utricle function bilaterally.

Left  
interamplitude

5.75

Right  
interamplitude

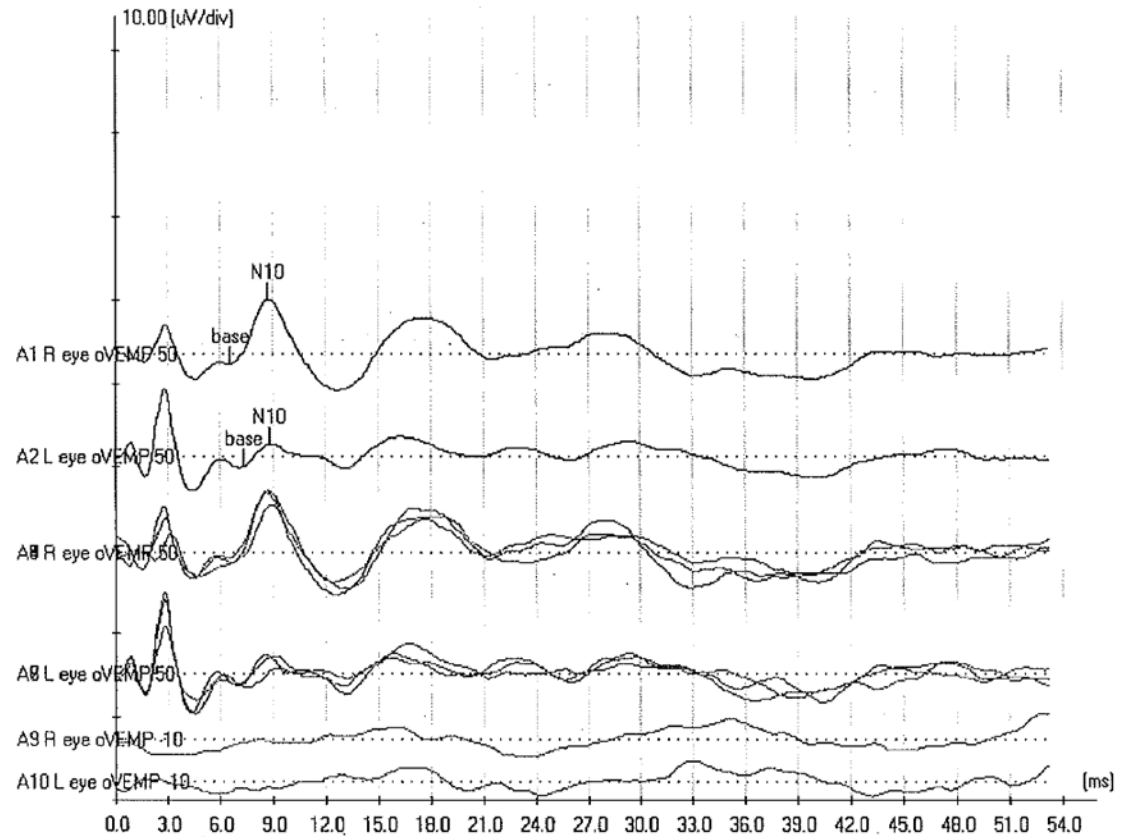
4.88



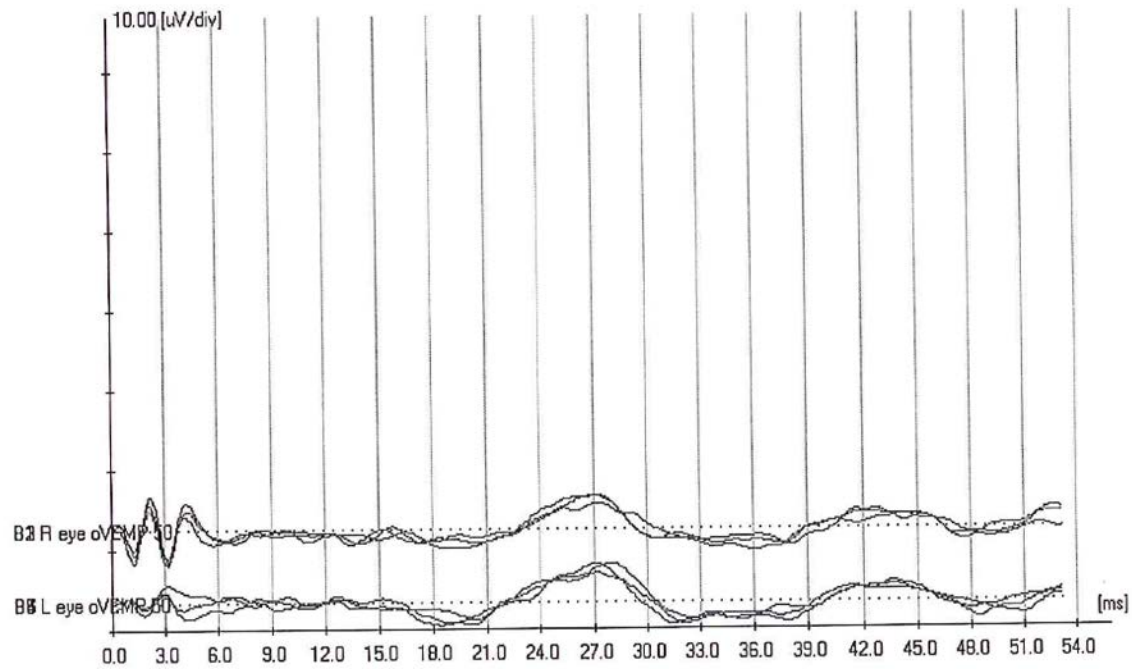
# Unilateral abnormal oVEMP

Consistent with a right utricle impairment.


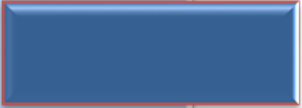
Left  
interamplitude  
6.99  
Right  
interamplitude  
0



# Inconclusive oVEMPs



# Advantages & disadvantages of oVEMP

- 
- 
- Information about otoliths/superior nerve function (localising information)
  - Absent oVEMPs in isolation are inconclusive
  - Does not provide a measure of central compensation
  - Contraindicated in recent retinal detachments and skull fractures

# Summary

- Balance and hearing testing is used for diagnostic purposes.
- The battery of tests is interpreted in combination to provide diagnostic information.
- Balance function testing records the 'output' of the vestibular reflexes in response to vestibular stimulation
  - Localizing information
  - May find signs of central disorders
  - Objective measure of central compensation.



# Referring for audiological care

- N.O. tests at RVEEH are Medicare funded and therefore referrals accepted from any medical source, except an ED.
- Provide sufficient referral information to allow for triage. The Hospital's referral guidelines can be found at [https://www.eyeandear.org.au/page/Health\\_Professionals/Referring\\_to\\_the\\_Eye\\_and\\_Ear/Referrals/](https://www.eyeandear.org.au/page/Health_Professionals/Referring_to_the_Eye_and_Ear/Referrals/)
- List of Audiology providers in community: <http://audiology.asn.au/index.cfm/consumers/audiology-services-directories/>
  - Note: fees vary.
  - There is no list of Neuro-otology centres.